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1 Papers from Hotnets-II: A case for run-time adaptation in packet processing systems ▬

Ravi Kokku, Taylor L. Riché, Aaron Kunze, Jayaram Mudigonda, Jamie Jason, Harrick M. Vin
January 2004 **ACM SIGCOMM Computer Communication Review**, Volume 34 Issue 1
Publisher: ACM Press
Full text available: 🔖 pdf(177.92 KB)   Additional Information: full citation, abstract, references

> Most packet processing applications receive and process multiple types of packets. Today,
> the processors available within packet processing systems are allocated to packet types at
> design time. In this paper, we explore the benefits and challenges of adapting allocations
> of processors to packet types in packet processing systems. We demonstrate that, for all
> the applications and traces considered, run-time adaptation can reduce energy
> consumption by 70--80% and processor provisioning level by 40 ...

2 Trading packet headers for packet processing ▬

Girish P. Chandranmenon, George Varghese
April 1996 **IEEE/ACM Transactions on Networking (TON)**, Volume 4 Issue 2
Publisher: IEEE Press

Full text available: 🔖 pdf(1.41 MB)   Additional Information: full citation, references, citings, index terms, review

3 Trading packet headers for packet processing ▬

Girish P. Chandranmenon, George Varghese
October 1995 **ACM SIGCOMM Computer Communication Review , Proceedings of the conference on Applications, technologies, architectures, and protocols for computer communication SIGCOMM '95**, Volume 25 Issue 4
Publisher: ACM Press

Full text available: 🔖 pdf(1.21 MB)   Additional Information: full citation, abstract, references, citings, index terms

> In high speed networks, packet processing is relatively expensive while bandwidth is
> cheap. Thus it pays to add information to packet headers to make packet processing
> easier. While this is an old idea, we describe several specific new mechanisms based on
> this principle. We describe a new technique, *source hashing*, which can provide $O(1)$
> lookup costs at the Data Link, Routing, and Transport layers. Source hashing is especially
> powerful when combined with the old idea of a *flow I* ...

4 Packet processing architectures: A methodology for evaluating runtime support in network processors

Xin Huang, Tilman Wolf

December 2006 **Proceedings of the 2006 ACM/IEEE symposium on Architecture for networking and communications systems ANCS '06**

Publisher: ACM Press

Full text available: pdf(1.78 MB)   Additional Information: full citation, abstract, references, index terms

Modern network processor systems require the ability to adapt their processing capabilities at runtime to changes in network traffic. Traditionally, network processor applications have been optimized for a single static workload scenario, but recently several approaches for run-time adaptation have been proposed. Comparing these approaches and developing novel run-time support algorithms is difficult due to the multicore system-on-a-chip nature of network processors. In this paper, we present a ....

Keywords: network processors, runtime management, workload partitioning and mapping

5 Network processor architecture: Overcoming the memory wall in packet processing: hammers or ladders?

Jayaram Mudigonda, Harrick M. Vin, Raj Yavatkar

October 2005 **Proceedings of the 2005 symposium on Architecture for networking and communications systems ANCS '05**

Publisher: ACM Press

Full text available: pdf(207.39 KB)   Additional Information: full citation, abstract, references, index terms

Overhead of memory accesses limits the performance of packet processing applications. To overcome this bottleneck, today's network processors can utilize a wide-range of mechanisms-such as multi-level memory hierarchy, wide-word accesses, special-purpose result-caches, asynchronous memory, and hardware multi-threading. However, supporting all of these mechanisms complicates programmability and hardware design, and wastes systemresources. In this paper, we address the following fundamental questi ...

Keywords: data-caches, multithreading, network processors

6 Automatically partitioning packet processing applications for pipelined architectures

Jinquan Dai, Bo Huang, Long Li, Luddy Harrison

June 2005 **ACM SIGPLAN Notices , Proceedings of the 2005 ACM SIGPLAN conference on Programming language design and implementation PLDI '05**, Volume 40 Issue 6

Publisher: ACM Press

Full text available: pdf(541.83 KB)   Additional Information: full citation, abstract, references, citings, index terms

Modern network processors employs parallel processing engines (PEs) to keep up with explosive internet packet processing demands. Most network processors further allow processing engines to be organized in a pipelined fashion to enable higher processing throughput and flexibility. In this paper, we present a novel program transformation technique to exploit parallel and pipelined computing power of modern network processors. Our proposed method automatically partitions a sequential packet proces ...

Keywords: live-set transmission, network processor, packet processing, parallel, pipelining transformation, program partition

7 Design space exploration for embedded systems: A framework for evaluating design
tradeoffs in packet processing architectures
Lothar Thiele, Samarjit Chakraborty, Matthias Gries, Simon Künzli
June 2002 **Proceedings of the 39th conference on Design automation DAC '02**
Publisher: ACM Press

Full text available: pdf(327.67 KB)   Additional Information: full citation, abstract, references, citings, index
terms

> We present an analytical method to evaluate embedded network packet processor
> architectures, and to explore their design space. Our approach is in contrast to those
> based on simulation, which tend to be infeasible when the design space is very large. We
> illustrate the feasibility of our method using a detailed case study.

8 Packet processing architectures: High-throughput sketch update on a low-power
stream processor
Yu-Kuen Lai, Gregory T. Byrd
December 2006 **Proceedings of the 2006 ACM/IEEE symposium on Architecture for
networking and communications systems ANCS '06**
Publisher: ACM Press

Full text available: pdf(787.77 KB) · Additional Information: full citation, abstract, references, index terms

> Sketch algorithms are widely used for many networking applications, such as identifying
> frequent items, top-k flows, and traffic anomalies. This paper explores the implementation
> of the Count-Min sketch update using Indexed SRF accesses on a SIMD stream processor
> (Imagine). Both the sketch data structure and the packet stream are modeled as streams,
> and in-lane accesses to the stream register file (SRF) support concurrent updates without
> explicit synchronization. The 500-MHz stream processor is ...

> **Keywords**: SIMD, VLIW, data stream processing, network processors, sketch, stream
> architecture

9 Packet processing architectures: Symerton--using virtualization to accelerate packet
processing
Aaron R. Kunze, Stephen D. Goglin, Erik J. Johnson
December 2006 **Proceedings of the 2006 ACM/IEEE symposium on Architecture for
networking and communications systems ANCS '06**
Publisher: ACM Press

Full text available: pdf(310.85 KB)   Additional Information: full citation, abstract, references, index terms

> The complexity of packet-processing applications continues to grow, with encryption,
> compression, and XML processing becoming common on packet-processing devices at the
> edge of enterprise and service provider networks. While performance remains a key
> differentiator for these devices, the complexity and rate of change in the supported
> applications has made general-purpose platforms an attractive alternative to ASICs and
> network processors. General-purpose platforms offer excellent programmability ...

> **Keywords**: communications systems, networking, virtualization

10 Flow management: Framework for supporting multi-service edge packet processing
on network processors
Arun Raghunath, Aaron Kunze, Erik J. Johnson, Vinod Balakrishnan
October 2005 **Proceedings of the 2005 symposium on Architecture for networking
and communications systems ANCS '05**
Publisher: ACM Press

Full text available: 📄 pdf(355.04 KB)   Additional Information: full citation, abstract, references, index terms

Network edge packet-processing systems, as are commonly implemented on network processor platforms, are increasingly required to support a rich set of services. These multi-service systems are also subjected to widely varying and unpredictable traffic. Current network processor systems do not simultaneously deal well with a variety of services and fluctuating workloads. For example, current methods of worst-case, static provisioning can meet performance requirements for any workload, but provisi ...

Keywords: edge packet processing, network processors, run-time adaptation

11 Managing memory access latency in packet processing

Jayaram Mudigonda, Harrick M. Vin, Raj Yavatkar

June 2005 **ACM SIGMETRICS Performance Evaluation Review , Proceedings of the 2005 ACM SIGMETRICS international conference on Measurement and modeling of computer systems SIGMETRICS '05**, Volume 33 Issue 1

Publisher: ACM Press

Full text available: 📄 pdf(69.62 KB)   Additional Information: full citation, abstract, references, citings, index terms

In this study, we refute the popular belief [1,2] that packet processing does not benefit from data-caching. We show that a small data-cache of 8KB can bring down the packet processing time by much as 50-90%, while reducing the off-chip memory bandwidth usage by about 60-95%. We also show that, unlike general-purpose computing, packet processing, due to its memory-intensive nature, cannot rely exclusively on data-caching to eliminate the memory bottleneck completely.

Keywords: data-caches, multithreading, network processors

12 Packet processing architectures: An effective network processor design framework: using multi-objective evolutionary algorithms and object oriented techniques to optimise the intel IXP1200 network processor

Liam Noonan, Colin Flanagan

December 2006 **Proceedings of the 2006 ACM/IEEE symposium on Architecture for networking and communications systems ANCS '06**

Publisher: ACM Press

Full text available: 📄 pdf(592.93 KB)   Additional Information: full citation, abstract, references, index terms

In this paper we present a framework for design space exploration of a network processor, that incorporates parameterisation, power and cost analysis. This method utilises multi-objective evolutionary algorithms and object oriented analysis and design. Using this approach an engineer specifies certain hard and soft performance requirements for a multi-processor system, and allows it to be generated automatically by competitive evolution/optimisation, thus obviating the need for detailed design. ...

Keywords: design space exploration, evolutionary approaches, object oriented

13 Reprogrammable network packet processing on the field programmable port extender (FPX)

John W. Lockwood, Naji Naufel, Jon S. Turner, David E. Taylor

February 2001 **Proceedings of the 2001 ACM/SIGDA ninth international symposium on Field programmable gate arrays FPGA '01**

Publisher: ACM Press

Additional Information: full citation, abstract, references, citings, index

Full text available: pdf(257.98 KB)   terms

A prototype platform has been developed that allows processing of packets at the edge of a multi-gigabit-per-second network switch. This system, the Field Programmable Port Extender (FPX), enables packet processing functions to be implemented as modular components in reprogrammable hardware. All logic on the on the FPX is implemented in two Field Programmable Gate Arrays (FPGAs). Packet processing functions in the system are implemented as dynamically-loadable modules.Core functi ...

Keywords: ATM, FPGA, IP, Internet, hardware, modularity, network, packet, processing, reconfiguration, routing

14 Session 38: communication-driven synthesis: Synthesis of high-performance packet processing pipelines
Cristian Soviani, Ilija Hadžić, Stephen A. Edwards
July 2006 **Proceedings of the 43rd annual conference on Design automation DAC '06**
Publisher: ACM Press
Full text available: pdf(821.60 KB)   Additional Information: full citation, abstract, references, index terms

Packet editing is a fundamental building block of data communication systems such as switches and routers. Circuits that implement this function are critical and define the features of the system. We propose a high-level synthesis technique for a new model for representing packet editing functions. Experiments show our circuits achieve a throughput of up to 40Gb/s on a commercially available FPGA device, equal to state-of-the-art implementations.

Keywords: FPGAs, high-level synthesis, networking, packet processors

15 Transport protocol processing at GBPS rates
N. Jain, M. Schawrtz, T. Bashkow
August 1990 **ACM SIGCOMM Computer Communication Review , Proceedings of the**
ACM symposium on Communications architectures & protocols
SIGCOMM '90, Volume 20 Issue 4
Publisher: ACM Press

Full text available: pdf(1.55 MB)   Additional Information: full citation, abstract, references, citings, index terms

This paper proposes an architecture for accomplishing transport protocol processing at Gbps rates. The limitations of currently used transport protocols have been analyzed extensively in recent literature. Several benchmark studies have established the achievable throughput of ISO TP4 and TCP to be in the low Mbps range; several new protocols and implementation techniques have been proposed to achieve 100 Mbps and higher throughput rates. We briefly review some of these protocols and establ ...

16 Software Processing Performance in Network Processors
I. Papaefstathiou, G. Kornaros, N. Zervos
February 2004 **Proceedings of the conference on Design, automation and test in**
Europe - Volume 3 DATE '04
Publisher: IEEE Computer Society
Full text available: pdf(126.22 KB)   Additional Information: full citation, abstract, index terms

To meet the demand for higher performance, flexibility, and economy in today's state-of-the-art networks, an alternative to the ASICs that traditionally were used to implement packet-processing functions in hardware, called network processors (NPs), has emerged. In this paper, we briefly outline the architecture of such an innovative network processor

aiming at the acceleration of protocol processing in high-speed network interfaces, and we use thisarchitecture as a case study for our measuremen ...

17 Improving network simulation: Considering processing cost in network simulations

Ramaswamy Ramaswamy, Ning Weng, Tilman Wolf

August 2003 **Proceedings of the ACM SIGCOMM workshop on Models, methods and tools for reproducible network research MoMeTools '03**

Publisher: ACM Press

Full text available: pdf(327.98 KB)   Additional Information: full citation, abstract, references

In many network simulations and models the cost of processing a packet is considered negligible or overly simplified. The functionality of routers is steadily increasing and complex processing of packet payloads is being implemented (deep packet classification, encryption, content transcoding). We show two examples where processing cost can contribute to a significant portion of the overall packet delay. To enable a more precise consideration of processing delay, we present a tool called NPEST (...

18 Session 7: embedded system techniques (2): Handling of packet dependencies: a critical issue for highly parallel network processors

Stephen Melvin, Yale Patt

October 2002 **Proceedings of the 2002 international conference on Compilers, architecture, and synthesis for embedded systems CASES '02**

Publisher: ACM Press

Full text available: pdf(221.66 KB)   Additional Information: full citation, abstract, references, citings, index terms

Network processors are being asked to perform increasingly complex operations on packets of information at faster and faster rates. Because processor performance and memory cycle times are not keeping up with this demand, there is a fundamental need for simultaneous processing of multiple packets, and the degree of this parallelism is increasing. Sometimes a dependency exists between two packets currently being operated on, and as the ratio of packet processing time to packet transmission time i ...

Keywords: memory synchronization, multithreaded processors, network processors, packet dependencies, packet processing, parallel processing, processor architecture, thread level speculation

19 Optimizing bulk data transfer performance: a packet train model

C. Song, L. H. Landweber

August 1988 **ACM SIGCOMM Computer Communication Review , Symposium proceedings on Communications architectures and protocols SIGCOMM '88**, Volume 18 Issue 4

Publisher: ACM Press

Full text available: pdf(1.34 MB)   Additional Information: full citation, references, citings, index terms

20 The effectiveness of affinity-based scheduling in multiprocessor network protocol processing (extended version)

James D. Salehi, James F. Kurose, Don Towsley

August 1996 **IEEE/ACM Transactions on Networking (TON)**, Volume 4 Issue 4

Publisher: IEEE Press

Full text available: pdf(1.71 MB)   Additional Information: full citation, references, citings, index terms

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